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Early Neural and Environmental Predictors of Later Emotion Dysregulation in Children with and without ADHD Symptoms

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EARLY NEURAL AND ENVIRONMENTAL PREDICTORS OF LATER EMOTION DYSREGULATION IN CHILDREN WITH AND WITHOUT ADHD SYMPTOMS

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by

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ABSTRACT

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Attention deficit/hyperactivity disorder (ADHD) is one of the most common childhood neurodevelopmental disorders and is characterized by excessive inattention and/or hyperactivity and impulsivity. There is evidence that many children with ADHD experience emotion dysregulation, but little is known about the mechanisms by which children with ADHD develop difficulties with emotion dysregulation. The goal of the present study is to identify early neural and environmental predictors of emotion dysregulation and determine whether these factors interact in contributing to later emotion dysregulation. In this study, children (aged 4-7) with ADHD symptoms and typically developing children participated. Measures of emotion socialization and neural measures of emotion reactivity and regulation were completed at the first visit. Follow-up was conducted 18 months later, and emotion dysregulation was assessed using parent report, child self-report, and observed affect during a frustration task. Supportive and unsupportive emotion socialization, distress reactions, and neural markers of reactivity and regulation (P1, N2, and P3) predicted later emotion dysregulation. Additionally, emotion socialization and neural markers during reactivity interacted in predicting later emotion dysregulation, such that neural markers predicted later emotion dysregulation in the context of low but not high quality emotion socialization. This study has implications for understanding mechanisms by which emotion dysregulation develops in children with ADHD symptoms and will aid in the development of targeted interventions for children with ADHD.

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CHAPTER I

EARLY ENVIRONMENTAL AND NEURAL PREDICTORS OF LATER EMOTION DYSREGULATION IN CHILDREN WITH AND WITHOUT ADHD SYMPTOMS

Overview

Attention deficit/hyperactivity disorder (ADHD) is one of the most common childhood disorders and is characterized by excessive inattention and/or hyperactivity and impulsivity (American Psychiatric Association, 2013). It is a highly heritable disorder thought to be caused by prefrontal cortical dysfunction that results in difficulties with executive control (Dickstein, Bannon, Xavier, Castellanos, & Milham, 2006). ADHD symptoms not only significantly interfere with functioning, but they also place children at increased risk for developing additional related problems, one of the most impairing of which is emotion dysregulation. Emotion dysregulation refers to an inability to exercise one or more aspects of the modulatory processes involved in emotion regulation, to such an extent that it leads to suboptimal functioning (Bunford, Evans, & Wymbs, 2015). Studies estimate that 24-50% of children with ADHD experience significant emotion dysregulation (Shaw, Stringaris, Nigg, & Leibenluft, 2014), which is associated with more impaired peer relationships, family life, occupational attainment, and academic performance (Bunford, Evans & Wymbs, 2015). These deficits have been established in school-aged children with ADHD, as well as in preschool children with ADHD symptoms (Sonuga-Barke, Thompson, Abikoff, Klein, & Brotman, 2006). However, little is known about the process by which children with ADHD symptoms develop difficulties with emotion dysregulation. Early childhood is a critical developmental period for developing emotion skills, so assessing risk factors for emotion dysregulation at a young age is especially important for understanding the early development of these difficulties.

Biological processes and early childhood experiences may lay the groundwork for later emotion dysregulation in children with ADHD symptoms. One important biological process that may contribute to the development of emotion dysregulation is altered neural functioning. Children with emotion dysregulation have shown altered event-related potentials (ERPs) in response to emotional inductions (Lewis & Steiben, 2004; Stieben et al., 2007), and our lab has extended these results to children with ADHD symptoms (Lugo-Candelas, Flegenheimer, Harvey, & McDermott, 2017). The neural functioning reflected by these altered ERPs may lay the groundwork for later emotion dysregulation. Early childhood experiences with emotion socialization, defined as the direct and indirect ways that parents teach their children to experience and express emotions (e.g., Hersh & Hussong, 2009), are also important for the development of emotion regulation in childhood, and may be especially important in the development of emotion regulation in children with ADHD (Breaux, McQuade, Harvey & Zakarian, 2018). Moreover, these environmental and neural factors may interact in contributing to the development of emotion dysregulation. There is some evidence that environmental factors in early childhood can impact the effects of biological characteristics on child functioning (e.g., McQuade & Breaux, 2017); however, no research has specifically examined if emotion socialization moderates neural risk for emotion dysregulation.

Emotion Reactivity and Regulation

Emotion reactivity refers to an individual's threshold, intensity, and duration of arousal for positive or negative emotions (Karass et al., 2006) and emotion regulation is defined as the ability to modulate the experience or expression of an emotional experience (Gross, 1998). In the Gross process model of emotion regulation, emotions are described as biologically-based reactions, and emotion regulation includes a spectrum of distinct but overlapping processes, from automatic to effortful, that modulate an individual's emotional response, the timing of the emotion, and emotional expression (Gross, 1998). Emotion reactivity and emotion regulation are linked, as strong emotional reactions require more emotion regulation than weak emotional reactions, and together are thought to affect emotional expression.

There is considerable evidence from parent-report, self-report, behavioral, and physiological studies that children with ADHD have difficulties with emotion reactivity and regulation. Parent-report and child self-report on rating scales indicate higher rates of lability and poorer emotion regulation in children with ADHD than typically developing children (e.g., Anastopoulos et al., 2011; Seymour et al., 2012; Stringaris & Goodman, 2009). Behavioral studies of children engaging in emotion tasks have found that children with ADHD self-report greater emotion and are observed to demonstrate greater reactivity in emotion-eliciting tasks (Douglas & Parry 1994; Maedgen & Carlson, 2000; Milich & Okazaki, 1991; Scime & Norvilitis, 2006). Further, when asked to regulate their emotions in a behavioral task, trained observers rated children with ADHD as less effective at using emotion regulation strategies (Walcott & Landau, 2004). These deficits in emotion reactivity and regulation have been noted across development in children with ADHD symptoms, from preschool to adolescence (Bunford et al., 2014; Sjowall, Backman, & Thorell, 2015).

The processes involved in the regulation of emotion require the activation of subcortical structures (such as the amygdala and ventral striatum) and cortical structures (such as the dorsal pre-frontal cortex and ventral pre-frontal cortex), as well as strong functional connectivity between these structures (Martin & Ochsner, 2016). In normative development, emotion regulation abilities improve with age, due in part to the increasing maturity of a child's cortical areas and increasing connectivity between cortical and subcortical areas (Martin & Ochsner, 2016). Children with ADHD symptoms may experience difficulties with emotion reactivity and emotion regulation early in life due to the same prefrontal underdevelopment that contributes to symptoms of inattention, hyperactivity, and impulsivity (Banaschewski et al., 2012). These difficulties may be stable over time, thus placing children at risk for later emotion dysregulation. In addition, greater reactivity in children with ADHD symptoms may interfere with the acquisition of emotion regulation skills, which in turn contributes to later emotion dysregulation. Understanding how neural processes contribute to the development of emotion dysregulation is especially important for young children at risk for ADHD, who are likely to have altered neural responses to emotion and develop emotion dysregulation.

Neural Markers of Reactivity and Regulation

Despite the substantial evidence from questionnaire and behavioral studies of emotion reactivity and regulation deficits in children with ADHD, very few studies have examined the neural mechanisms of reactivity and regulation in children with ADHD symptoms. A complete understanding of the underlying processes that lead to emotion dysregulation in children with ADHD symptoms requires examination not only of behavioral but also neural indicators of key aspects of emotional responses. Neural differences may occur before noticeable behavioral differences emerge, so neural correlates may allow us to understand deficits at an even younger age. Event-related potentials (ERPs) are a non-invasive measure of neural electrophysiological responses. Children with emotion dysregulation have been demonstrated to show differential changes in ERP components during emotion-eliciting tasks at fronto and fronto-central locations (Lewis & Steiben, 2004; Stieben et al., 2007; Rich et al., 2007). Some of the altered ERP components that have been indicated in children with emotion dysregulation include the P1 (positive deflection around 100 ms post stimulus onset involved in early attention processing), the N2 (negative deflection peaking around 200 ms poststimulus involved in inhibitory control) and P3 (positive deflection peaking around 300 ms poststimulus involved in attention) components. These findings indicate that ERPs may be a promising source for understanding mechanisms underlying the development of emotion dysregulation in children with ADHD symptoms. Our laboratory produced one of the few published study of ERP correlates of emotion reactivity and regulation in children with ADHD symptoms, which found that children with ADHD symptoms had altered neural patterns while attempting to regulate their emotions (Lugo-Candelas, Flegenheimer, Harvey et al., 2017). Typically developing children demonstrated attenuated N2 and increased P3 amplitudes at frontal and fronto-central regions when they experienced frustration relative to baseline, whereas children with ADHD symptoms did not modulate their N2 or P3 amplitudes across conditions. This pattern suggests that children with ADHD were not as effective as modulating cognitive control and allocation of attention during reactivity. More research using ERP with children with ADHD symptoms is necessary to better understand the mechanisms by which children with ADHD symptoms develop emotion dysregulation.

Emotion Socialization

Previous research indicates that emotion socialization is important in the development of emotion regulation in children (e.g., Cole, Dennis, Smith-Simon, & Cohen, 2009). In particular, supportive parental responses include validating and coaching a child through an emotional experience, whereas non-supportive parental responses include dismissing or punishing a child’s emotional expression. Longitudinal studies have found that early supportive emotion socialization is associated with positive emotional and behavioral outcomes, and that non-supportive emotion socialization is associated with worse emotional and behavioral outcomes (Denham & Kochanoff, 2002; Denham, Kendziora & Cole, 2000; Gottman, Katz & Hooven, 1996; Johnson, Hawes, Eisenberg, Kohlhoff, & Dudeney, 2017; Kahle, Grady, Miller, Lopez & Hastings, 2017; Karstad, Wichstrom, Reinfjell, Belsky & Berg-Nielson, 2015; Scrimgeour, Davis & Buss, 2016; Warren & Stifter, 2008).

Limited research has longitudinally assessed the relation between emotion socialization in early childhood and emotion dysregulation (Blair et al., 2014; Garner, 1999; Newland & Crnic, 2011), but these results suggest that emotion socialization in early childhood contributes to later emotion regulation. However, these studies assessed very specific facets of emotion regulation (e.g., observed angry expressions during a frustrating task or parent-report) and none used a multi-method approach to assess emotion regulation. Because emotion regulation is a complex and multi-faceted skill set, using multiple measurement methods may be especially important in order to capture it fully. Additionally, these studies focused on typically developing children. Research is needed to extend these findings to children at risk for psychopathology. Children with ADHD symptoms are at higher risk for emotion dysregulation, so understanding the contribution of emotion socialization to emotion dysregulation in this population is especially important. In older children with ADHD symptoms, emotion socialization is particularly important in contributing to emotion dysregulation (Breaux et al., 2018), and this may be true for younger children with ADHD symptoms as well.

Interplay of Emotion Socialization and Neural Markers

Previous research has shown that emotion socialization can moderate the relation between risk factors for emotion dysregulation and the subsequent development of emotion dysregulation. For example, high quality emotion socialization can mitigate the impact of exposure to interparental aggression on later emotion regulation (Caiozzo, Yule, & Grych, 2018). Additionally, the association between child negative reactivity and emotion regulation is moderated by emotion socialization (Mirabile, Scaramella, Sohr-Preson, & Robison, 2009). There is evidence that emotion socialization may also moderate the expression of biological predispositions for emotion dysregulation. For example, emotion socialization moderates the relation between parasympathetic nervous system responses and emotion dysregulation (Hastings & De, 2008; Scrimgeour et al., 2016; McQuade & Breaux, 2017; Perry, Calkins, Nelson, Leerkes, & Marcovitch, 2011).

No research has directly assessed whether emotion socialization moderates the relation between neural markers of reactivity and later emotion dysregulation, but theory and research suggest that it may. There is evidence that environmental factors such as adverse childhood events can influence brain development (McLaughlin, Sheridan &

Lambert, 2014); through similar processes, supportive emotion socialization in early childhood may positively influence later neural structures and responses involved in emotion regulation development. Additionally, high quality emotion socialization may offer children with altered neural responses additional opportunities to acquire emotion regulation skills, thereby protecting them from the development of later emotion dysregulation. Understanding the potential protective role of emotion socialization in early childhood will offer important treatment targets for children whose neural response may put them at-risk for emotion dysregulation.

The Present Study

There is evidence that many children with ADHD have difficulties with emotional dysregulation, but little is known about the processes that lead to the development of difficulties with emotion dysregulation in children at risk for ADHD. This study will address this gap in the literature by identifying early neural and environmental predictors of emotion dysregulation as well as by assessing the interaction of these factors in predicting later emotion dysregulation. More specifically, this study will examine neural responses to emotion reactivity and regulation using ERP, as well as emotion socialization as early predictors of emotion dysregulation. In order to most accurately capture the multifaceted construct of emotion dysregulation, this study will use a multi-method assessment approach. In order to better capture a range of neural responses and emotion dysregulation across the clinical spectrum, this sample includes children with and without ADHD symptoms.

The current study provides a follow-up of our lab's previous work, which found that children with ADHD symptoms had altered neural patterns, specifically surrounding

N2 and P3 components, while attempting to regulate their emotions (Lugo-Candelas, Flegenheimer, Harvey, & McDermott, 2017). The present study follows the children in our original ERP study 18-months later to assess whether this early altered neural activity predicts later emotion dysregulation. Specifically, this study will address the following questions:

1. Does early emotion socialization predict later emotion dysregulation? Previous literature has established that emotion socialization practices are associated with emotion dysregulation in typically developing children (Cole et al., 2009) and these findings have recently been extended to older children with ADHD (Breaux et al., 2018). Therefore, I predict that supportive emotion socialization of young children will be predictive of less emotion dysregulation and non-supportive emotion socialization practices will be predictive of greater emotion dysregulation.

2. Do neural indicators of early reactivity and regulation predict later emotion dysregulation? Previous literature has suggested that ERP components, notably the P1, N2, and P3, assessed during emotionally challenging tasks, are compromised in children with ADHD symptoms, and may be important markers for difficulty with emotion reactivity and regulation. Based on previous research (Lewis et al., 2006; Lewis & Stieben, 2004; Stieben et al., 2007, Lugo-Candelas et al., 2017), I predict that stronger N2 (larger amplitude) will be predictive of later emotion dysregulation, as a need for more cortical resources of inhibitory control during an emotional task may indicate underlying difficulties regulating emotions. Consistent with Lugo-Candelas et al. (2017) and Rich et al. (2007), I also predict that decreased P3 and P1 amplitudes across emotion-eliciting tasks will be predictive of later emotion dysregulation, because the cortical burden for managing emotions will result in deficits in early attention processing and reduced attention allocation to the task in children at risk for later emotion dysregulation.

3. Do emotion socialization and neural markers of reactivity interact in predicting later emotion dysregulation? For children with neural processes that place them at risk for emotion dysregulation, high quality emotion socialization may provide an opportunity to learn emotion regulation skills that allow them to moderate the impact of these neural processes. Therefore, I predict that high quality emotion socialization will moderate the association of early neural markers and later emotion dysregulation, such that the relation between neural markers and emotion dysregulation will be weaker for children who receive high quality emotion socialization.

Method

Participants

Participants were 68 children (45 males, 22 females, 1 transgender girl) aged 4 to 7 years (*M* = 6.41 years, *SD* = 0.88) who participated in a longitudinal study of emotion competence. The present sample included 31 children with ADHD symptoms (8 girls, 23 boys) at the time of the first visit and 37 typically developing (TD) children (23 males, 13 females, 1 transgender girl). Children were predominantly European American (79.6% European American, 17.6% multiethnic, 2.9% Latino, 1.5% African American, 1.5% Asian American). On average, parents were highly educated (*M* = 16.76 years of education, *SD* = 1.94). At the time of the second visit, children were between 6 and 9 years old (*M* = 8.18, *SD* = 0.80). Forty-nine children (16 girls, 33 boys) returned for the second visit (32 TD children, 17 children with ADHD symptoms).

Procedure

Participants were recruited through a child participant database, advertisements placed in pediatrician offices and community centers, and flyers sent to preschools. A phone interview that included the ADHD and oppositional defiant disorder (ODD) sections of the NIMH Diagnostic Interview Schedule for Children (NIMH DISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000) was conducted to assess eligibility criteria. Children were included in the ADHD symptom group if parents reported at least six symptoms of hyperactivity on the DISC-IV, at least three of which occurred at both home and at school/daycare. Because it is argued that ADHD primarily inattentive presentation is distinct from other ADHD presentations, and typically onsets later in childhood (Applegate et al., 1997), it was not deemed feasible to examine this presentation, and therefore only hyperactivity symptoms were utilized as inclusion criteria. Children who were taking medication for ADHD were asked to not take their medication in the 48 h prior to the study. Children were included in the TD group if parents reported no more than three symptoms of hyperactivity on the DISC-IV. Exclusion criteria for both groups included parental reports of intellectual disabilities, hearing or visual disabilities, receptive language delay, cerebral palsy, epilepsy, autism, or psychosis.

For both study visits, parents provided consent and children provided verbal assent. At the first visit (Time 1), children were fitted for an EEG/ERP cap, and parents completed questionnaires while the children completed study activities. Approximately 18 months after the first visit (Time 2), families were invited back to the lab. Again, parents completed questionnaires while children completed a different frustration task and an orally-administered questionnaire (no EEG data were collected). For each visit, families were paid $20 and children received a small prize. The study was approved by the university’s Institutional Review Board.

Time 1 Measures

Demographic questionnaire. Parents completed a demographic questionnaire assessing contextual variables such as parent age, marital status, parent education, and race.

Emotion socialization. Parents completed the Coping with Children’s Negative Emotions Scale (CCNES; Fabes, Eisenberg, & Bernzweig, 1990) as a measure of parent emotion socialization. The CCNES describes 12 hypothetical scenarios in which a child is upset or angry (e.g., “If my child loses some prized possession and reacts with tears, I would”). For each scenario, parents rate the likelihood on a 7-point Likert scale (1 = *Very Unlikely*, 7 = *Very Likely*) that they would respond with six different types of reactions. Reactions are collapsed into supportive and non-supportive emotion socialization practices. Based on prior studies (Eisenberg, Cumberland, & Spinrad, 1998; Eisenberg, Fabes, & Murphy, 1996; Fabes, Leonard, Kupanoff, & Martin, 2001), supportive reactions included the Expressive Encouragement Reactions (e.g., “tell him/her it's OK to cry when you feel unhappy”), Emotion-Focused Reactions (e.g., “distract my child by talking about happy things”), and Problem Focused Reactions (e.g., “help my child think of places he/she hasn't looked yet”); non-supportive reactions included Punitive Reactions (e.g., “tell him/her that's what happens when you're not careful”) and Minimization Reactions (e.g., “tell my child that he/she is over-reacting”). Consistent with prior studies indicating that Distress Reactions (e.g., “get upset with him/her for being so careless and then crying about it") have different properties than Punitive and Minimization Reactions (Fabes et al., 2001), Distress Reactions were considered separately. The CCNES has been shown to have good reliability (Fabes, Poulin, Eisenberg, & Madden-Derdich, 2002).

Neural markers of emotion reactivity and regulation: Modified Affective Posner. At Time 1, in order to assess neural markers of reactivity and regulation, children completed a modified version of the Affective Posner task, which is a frustration task (Pérez-Edgar & Fox, 2005). This task discriminates children with and without emotional regulation difficulties (Rich et al., 2007) and has been previously used in children as young as 6 years (Pérez-Edgar, Fox, Cohn, & Kovacs, 2006). In this version, three boxes (underwater treasure chests) were presented horizontally on a computer screen, followed by a cue (a white dot that appeared in one of the boxes) and then a target (a yellow star in one of the boxes). Three types of trials were presented: valid (in which the dot appeared in the same box as the target), invalid (in which the dot appeared in a different box from the target), and control (in which the dot appeared in the center box and the target appeared in a side box). Children were instructed to press the button corresponding to the location of the star. There were 236 total trials presented across four blocks. Before starting the task, children were told the computer was "having problems" and at times the buttons got "mixed up." They were told to continue playing even if the computer was having problems. After each trial, feedback was provided. A 'thumbs up' or 'thumbs down' icon appeared if the trial was correct or incorrect, respectively. Children were given an underwater passbook, and told they had to collect four stamps, one for each block, to get a prize. They were told that they needed to collect many points in order to get a stamp. The task, including breaks, lasted approximately 18 min. To ensure children understood the task, they completed at least one practice round.

The task was administered in four blocks: ***1) Baseline Block.*** This condition was affectively ‘neutral,’ with children winning points for every correct response. This condition consisted of 40 trials and children received a stamp after this block. ***2) Reactivity Block.*** This condition was designed to induce negative affect. It consisted of 78 trials, and on 40% of these trials, the button was seemingly broken and children received inaccurate feedback that their (correct) response was incorrect. At the end of this block, children were told that they did not collect enough points for a stamp, but they would receive another chance to receive one. ***3) Regulation Block.*** This condition was identical to the reactivity block, but children were asked to suppress emotional expression. Consistent with Bar-Haim et al. (2011), before beginning the trial children were told to play so “no one is able to know by your behavior whether you are winning or losing the game.” At the end of this block, children were told that they would get a stamp for both this block and the prior one because the computer had been malfunctioning. ***4) Recovery Block.*** In this 40-trial condition, the button “worked properly” once again and children were given the final stamp. This condition allowed the children to return to a more positive affective state before leaving the laboratory.

Psychophysiological recording and data reduction. ERP data was collected during the Modified Affective Posner task. Electroencephalogram (EEG) was recorded using Ag-AgCl electrodes in a 64-channel Lycra Electro-Cap setup in accordance with the International 10–20 System. Eye movements were regressed from the data. Mastoid electrodes served as reference and impedances were kept less than 10 kΩ for the

Modified Affective Posner task. Data were filtered (0.01–100 Hz), amplified and digitized (1000 Hz), and then filtered again during processing with a 30 Hz low-pass filter. EEG was baseline corrected, and trials containing artifacts (epochs exceeding an EEG voltage threshold of ±150μV) were removed and excluded from analysis.

ERPs were time locked to target onset and constructed by averaging epochs separately for each target type (valid, invalid, and control) for each block. Consistent with previous literature on this task with young children, analyses focused on the mean amplitudes of the P1 (scored in a window of 10-100 ms post stimulus onset), N2 (scored in a window of 50-220 ms post stimulus onset), and P3 (scored in a window of 130- 400 ms post stimulus onset). For the P1 and N2, analyses were focused at frontal (F3, F4, and FZ) regions and for the P3, analyses were focused at frontal-central (FC3, FC4, and FCZ) regions (e.g., Lugo-Candelas et al., 2017; Rich et al. 2005; Rich et al., 2007).

Time 1 and Time 2 Measures.

Parent-report of child emotion dysregulation. At Time 1 and Time 2, parents completed the Emotion Regulation Checklist (ERC; Shields & Cicchetti, 1997), a 24-item questionnaire that measures children's reactions to emotional events. Parents rated items on how characteristic they were of their children from 1 (rarely/never) to 4 (almost always) and responses were averaged to create subscale scores. The emotional regulation subscale assesses appropriate responses to emotional contexts, and the lability–negativity subscale measures mood lability, lack of flexibility, and dysregulated negative affect. The ERC has good validity and both subscales have shown good reliability in previous studies (α = .96 and α = .83, respectively; Shields & Cicchetti, 1997).

Time 2 Measures

Observed frustration. At Time 2, children completed the Transparent Box frustration task, which is commonly used in preschool and school-aged children, and is designed to elicit frustration and was used to measure emotion regulation (Laboratory Temperament Assessment Battery; Goldsmith & Rothbart, 1996). Children were given a transparent box with a desired toy locked inside and a set of keys (unknown to the child, none of the keys could open the box). The experimenter then left the room for 4 min, and the child's behavior was videotaped. When the experimenter returned, she told the child that they had been given the wrong set of keys, and gave the child the correct set of keys and let the child try again.

Behaviors and emotional expressions during the transparent box task were coded using a coding system adapted from Dennis (2006). The present study focused on the emotion expression coding. The presence/absence of three types of emotional expression (anger/frustration, sadness, happiness) were coded for each 10-s epoch. Emotional expression was based on facial, vocal, or postural cues. Ratings of emotional expression were summed and divided by the number of epochs. Three undergraduate research assistants who were unaware of participants' group status coded tapes. Due to limited variability and low ratings of sadness and happiness, only ratings of anger/frustration were used in these analyses. To evaluate interrater reliability, sixteen tapes were coded by two assistants. To assess inter-rater reliability, Gwet's AC1 was calculated (Gwet, 2010), which is suggested over Cohen's kappa when data are skewed (Wongpakaran, Wongpakaran, Wedding & Gwet, 2013; AC1 = 0.90).

Child self-report of emotion dysregulation. A scale entitled "Youth Emotion Scale" (YES) was developed by the researchers for the purpose of this study and used at Time 2. It featured 28 items describing emotional experiences (e.g., "I have a hard time calming down when I get upset"). Each item featured a Likert scale, asking children to rate whether the statement was (1) Not True; (2) A Little True; (3) True; or (4) Very True for them. This measure was designed to assess children's emotion reactivity, emotion regulation strategies, and dysregulated emotion expression. To determine factor structure, a principal components factor analysis with a direct oblimin rotation analysis was conducted, which identified a three-factor solution (see Table 1), with 26 items loading on these three factors. Eleven items loaded on the first factor, which accounted for 19.56% of the variance (eigenvalue = 5.47), six items loaded on the second factor, which accounted for 13.13% of the variance (eigenvalue = 3.67), and nine items loaded on the third factor, which accounted for 8.68% of the variance (eigenvalue = 2.43). The first factor contained items that describe adaptive strategies for emotion regulation and was named *Adaptive Emotion Regulation (Adaptive ER).* The second factor contained items that describe heightened sensitivity to negative emotions as well as prolonged duration of negative emotion, and was named *Reactivity.* The third factor contained items that described maladaptive or ineffective emotion regulation, and was named *Maladaptive Emotion Regulation (Maladaptive ER).* Items on each factor were averaged to create three scores for each child. Cronbach's alpha for these subscales were fair to high (Adaptive ER = .86; Reactivity = .76; Maladaptive ER = .64).

Data Analysis

MPlus Version 8 (Muthen & Muthen, 1998-2017) was used for all analyses. The lability and emotion regulation subscales of the ERC were highly correlated at both time points and therefore the two subscales were collapsed into one ERC score for each time point. Therefore, there were five emotion dysregulation outcomes at Time 2: three child-report emotion dysregulation scores from the YES (Adaptive ER, Reactivity, and Maladaptive ER), one parent-report emotion dysregulation (ERC), and one observed measure of emotion dysregulation. Because gender was highly correlated with the ERC, gender was used as a control in all analyses. The ERC at Time 1 was used as a control in all analyses in order to control for the effects of Time 1 emotion dysregulation on Time 2 emotion dysregulation.

To examine if emotion socialization and neural markers of reactivity and regulation predict later emotion dysregulation, Time 2 measures of the ERC, YES, and observed frustration were regressed on Time 1 measures of emotion socialization and neural markers of emotion reactivity and regulation, controlling for gender and Time 1 ERC.

To examine interactions between emotion socialization and neural markers, an overall emotion socialization quality variable was calculated by averaging the three supportive emotion socialization subscales and the inverse of the three unsupportive emotion socialization subscales; higher scores indicated high supportive emotion socialization and low unsupportive emotion socialization. This variable was tested as a moderator of Time 1 neural markers (P1, N2, and P3) during the reactivity block of the Posner task on Time 2 emotion dysregulation outcomes. Only neural markers during the reactivity block of the Posner task were examined in the interactions, as the focus of the research question is on whether environmental experiences moderate the expression of neural markers of reactivity. All predictors were centered prior to creating interaction terms. Interaction terms were created by multiplying emotion socialization quality by the neural marker (P1, N2, and P3) mean amplitude during the reactivity block. Regressions were then run separately for each neural marker, with emotion socialization, the neural marker, and the interaction term as predictors. Gender, Time 1 ERC, and the neural marker during the other three conditions were controls. These analyses were conducted separately for each of the five emotion dysregulation outcome measures. In all analyses, full information maximum likelihood was used to address missing data.

Results

Attrition

Nineteen children did not return for the Time 2 visit. A one-way ANOVA indicated that children who completed Time 2 showed lower Time 1 H/I (M = 3.06, SD = 3.38) than children who did not return at Time 2 (M = 5.52, SD = 3.55), t (67) = -2.66, p = .010. Children who completed Time 2 showed lower Time 1 emotion dysregulation, as measured by the parent-reported ERC (M = 1.65, SD = .39), than those who did not (M = 1.97, SD = .38), t (66) = -3.07, p = .003. Children who completed Time 2 showed higher Time 1 reports of positive parental emotion socialization (M = 5.83, SD = .59) than those who did not (M = 5.23, SD = .70), t (65) = 3.53, p = .001. There was no significant difference between children who did and did not complete Time 2 across all other parent-reported, neural, and demographic measures collected at Time 1.

Descriptive Statistics

Descriptive statistics and intercorrelations between variables are provided in Table 2.

Do Emotion Socialization and Neural Markers Predict Later Emotion Dysregulation?

Full regression results are presented in Table 3 and are summarized here.

Emotion Socialization. Higher supportive emotion socialization and higher distress reactions at Time 1 both predicted lower observed frustration at Time 2, controlling for Time 1 ERC and gender. Higher unsupportive emotion socialization at Time 1 predicted higher ERC at Time 2, controlling for Time 1 ERC and gender. No emotion socialization variable predicted any of the child-reported emotion dysregulation outcomes.

Neural Markers of Reactivity and Regulation. Higher P1 amplitude in the recovery block at Time 1 predicted higher observed frustration at Time 2, controlling for P1 in other blocks, gender, and Time 1 ERC. There were no associations between P1 mean amplitude during the baseline, frustration, and regulation blocks at Time 1 and later emotion dysregulation, controlling for P1 in other blocks, gender and Time 1 ERC.

Weaker N2s (less negative mean amplitude) during the regulation block was associated with higher Time 2 ERC scores, controlling for N2 in other blocks, gender, and Time 1 ERC. Weaker N2s during the reactivity block were associated with higher Time 2 YES Adaptive ER scores, controlling for N2 in other blocks, gender, and Time 1 ERC. There were no other associations between N2 mean amplitude during any of the blocks at Time 1 and Time 2 emotion dysregulation.

Larger P3 mean amplitude during the reactivity block predicted higher scores on the YES Adaptive ER subscale, controlling for P3 in other blocks, gender and parent-reported Time 1 ERC. Larger P3 during the reactivity block was associated with lower

Time 2 YES Maladaptive ER scores, controlling for P3 in other blocks, gender and parent-reported Time 1 ERC. Larger P3s during the regulation block predicted higher Time 2 ERC, controlling for P3 in other blocks, gender, and Time 1 ERC. There were no associations between P3 mean amplitude during the recovery block and any of the Time 2 emotion dysregulation variables, controlling for P3 in other blocks, gender, and parent-reported Time 1 ERC.

Do Emotion Socialization and Neural Markers of Emotion Reactivity Interact in Predicting Later Emotion Dysregulation?

Interaction regressions are presented in Table 5. For significant interactions, simple slopes were calculated at average quality emotion socialization, as well as one standard deviation above the mean (high quality emotion socialization) and one standard deviation below the mean (low quality emotion socialization). Simple slopes for significant interactions are presented in Tables 6. All analyses controlled for gender, Time 1 ERC, and the respective neural marker during the baseline, regulation, and recovery blocks.

P1 and emotion socialization. There was a significant interaction between P1 during reactivity and emotion socialization in predicting later YES Adaptive ER, YES Reactivity, and later observed frustration. In the presence of high quality emotion socialization, P1 during reactivity was not associated with later YES Adaptive ER, YES Reactivity, or observed frustration. In the presence of average quality emotion socialization, P1 during reactivity was not associated with YES Adaptive ER, but higher P1 amplitude was associated with lower YES Reactivity and greater observed frustration. In the presence of low quality emotion socialization, higher P1 during reactivity was associated with higher YES Adaptive ER, higher observed frustration, and lower YES Reactivity.

N2 and emotion socialization. There was a significant interaction between N2 during reactivity and emotion socialization in predicting later YES Adaptive ER. In the presence of average quality emotion socialization and low quality emotion socialization, weaker N2 (more positive amplitude) was associated with later lower YES Adaptive ER. However, in the presence of high quality emotion socialization, N2 during reactivity was not significantly associated with YES Adaptive ER.

P3 and emotion socialization. There was a significant interaction between P3 during reactivity and emotion socialization in predicting later YES Adaptive ER and Maladaptive ER. In the presence of average quality emotion socialization or low quality emotion socialization, lower P3 during reactivity was associated with lower YES Adaptive ER and higher YES Maladaptive ER. However, in the presence of high quality emotion socialization, P3 during reactivity was not associated with later YES Adaptive ER or Maladaptive ER.

Discussion

The goal of this study was to examine early predictors of emotion dysregulation in young children with and without ADHD. Specifically, emotion socialization and neural markers of emotion reactivity and regulation were tested as predictors of later emotion dysregulation. Additionally, their potential interaction in predicting emotion dysregulation was assessed. Results indicated that lower levels of supportive emotion socialization practices and higher levels of unsupportive emotion socialization practices were predictive of more emotion dysregulation. Additionally, results suggested that neural markers of attention and inhibitory control during reactivity, while regulating frustration, and after a frustrating experience were predictive of later emotion dysregulation. Results suggested that the association between neural markers and later emotion dysregulation is moderated by emotion socialization, such that in the context of high quality emotion socialization, the relation between neural markers and emotion dysregulation became nonsignificant. Taken together, these findings suggest that emotion socialization and neural markers have individual direct effects and interact in predicting the development of emotion dysregulation. Because children with ADHD symptoms are at risk for both altered neural responses to emotional contexts and emotion dysregulation, these findings offer insight into the development of emotion dysregulation in young children with ADHD symptoms.

Emotion Socialization

Supportive emotion socialization practices predicted later lower observed frustration, and unsupportive emotion socialization practices predicted later higher parent-reported emotion dysregulation. This finding is consistent with previous literature that has found that supportive emotion socialization practices are related to later lower emotion dysregulation and unsupportive emotion socialization practices are related to later high emotion dysregulation (e.g., Breaux et al., 2018; Blair, 2014). However, this is the first longitudinal study to demonstrate this in an early childhood sample with elevated symptoms of psychopathology. These results indicate that the impact of emotion socialization on the development of emotion dysregulation likely begins very early in life. Contrary to prediction, distress reactions (i.e., a parent demonstrating distress when their child experiences difficult emotions), often considered a unsupportive emotion socialization practice, was not related to parent-reported emotion dysregulation and predicted later lower observed frustration. Previous research on the relation between distress subscale of the CCNES indicated that the subscale may function differently than other unsupportive emotion socialization practices, as it seems to be inconsistently related to negative child outcomes (e.g., Eisenberg, 1998). Our finding is consistent with some previous research that has also found greater distress reactions to be associated with less observed negative emotionality, though only in the context of high levels of minimizing/punitive responses (Fabes et al., 2001). It may be the case that children of parents with high distress reactions learn to suppress their expression of negative emotions as a means of protecting their parent, a strategy that may limit the observation of negative emotion but not necessarily be related with positive emotion regulation abilities. Previous research on the relation between the distress subscale and parent-reported emotionality measures have been mixed. Our finding of no association between this subscale and child emotion dysregulation is consistent with other research that found that maternal distress reactions were not associated with parent-reported emotionality (Eisenberg et al., 1996); however, other studies have found that distress reactions are correlated with parent-reported emotional intensity and negative affect (Eisenberg & Fabes, 1994). This inconsistent association may be because distress responses to a child's emotions could be interpreted differently across contexts.

Neural Markers of Reactivity and Regulation

Higher P1 amplitude during recovery predicted higher observed frustration. This finding stands in contrast to Rich et al. (2007), who found that children with severe mood dysregulation showed lower P1 amplitude across a variety of Posner tasks. However, there were some important methodological differences between these studies. Rich et al. (2007) indexed mood dysregulation based on DSM-IV diagnosis, and our finding is with observed frustration. Some amount of expressed frustration during a frustrating lab task may actually be a productive emotional coping strategy (as compared to suppressing emotions). Additionally, in the current study, trials with correct/incorrect feedback were presented in blocks, resulting in prolonged frustrating and recovery experiences. Rich et al., (2007) presented trials of correct vs. incorrect feedback in random order, thereby not having a true “recovery” period. The P1 is considered an index of early attention processing, and so this heightened P1 during recovery may indicate heightened early attention. In the context of having been told that the computer was “functioning” again, this may be a neural indicator of difficulty returning to baseline following frustration, or heightened excitement about the impending reward.

During reactivity, higher P3 and weaker N2 predicted higher child reported use of adaptive emotion regulation strategies, and higher P3 predicted lower child reported use of maladaptive emotion regulation strategies. This is consistent with Rich et al. (2007), who found that children without emotion dysregulation demonstrated increased P3 during reactivity compared to children with emotion dysregulation. This higher attention allocation (P3) during reactivity may indicate increased cortical resources being allocated in response to emotion. The decreased inhibitory control response (N2) may indicate a reduced need for cognitive control during reactivity, perhaps because of lower reactivity or more efficient cognitive control. Conversely, higher P3 during the regulation block predicted higher parent-reported emotion dysregulation. This higher P3 may indicate a greater need for more cortical attentional resources in order to regulate emotions compared to well-regulated peers. Similarly, weaker N2 during regulation predicted higher emotion dysregulation. Because greater allocation of inhibitory control resources during the frustration condition was predictive of worse emotion dysregulation, reduced allocation during the regulation condition may be reflective of depleted cognitive resources following frustration.

Emotion Socialization by Neural Markers Interactions

Emotion socialization quality moderated the association between neural markers during emotion processing and emotion dysregulation. In low and moderate quality emotion socialization conditions, neural markers were predictive of emotion dysregulation; however, in the presence of high quality emotion socialization, these associations were nonsignificant. These findings suggest that high quality emotion socialization may have a protective effect against emotion dysregulation in children whose neural underpinning place them at-risk for emotion dysregulation. High quality emotion socialization may offer children additional support in learning emotion regulation skills, and these additional opportunities for learning these skills may be especially important for children at-risk for emotion dysregulation. It is also possible that, over time, high quality emotion socialization improves children’s neural responses to emotional situations. These findings suggest that for children who have neural vulnerabilities during reactivity, high quality emotion socialization from caregivers may be an important treatment target for improving emotion regulation.

Interestingly, five of the six interactions involved child self-report, suggesting that child self-report may tap into underlying neural processes better than outward expression of emotion. These findings highlight the importance of a multi-method approach to studying emotion dysregulation, and suggest that it may be particularly important to assess a child's perspective into their own experiences of dysregulation in order to fully understand the development of emotion dysregulation in children.

Limitations

These findings should be considered in light of some important limitations. First, this study oversampled children with ADHD symptoms to examine these processes in children at risk for ADHD. However, children were selected based solely on parent endorsement of clinical levels of ADHD symptoms, rather than ADHD diagnosis, which may limit generalizability to children with ADHD. Second, the sample was not racially diverse, and therefore did not allow for comparisons across racial/ethnic groups. There is evidence that the impact of emotion socialization practices varies across cultural groups (e.g., Breen, Tamis-LeMonda, & Kahana-Kalman, 2016; Raval & Walker, 2019), and, as such, these results should be considered to largely apply to European American families. There may be important differences in the impact of emotion socialization and development of emotion dysregulation in other racial/ethnic groups. Third, children who did not return for the Time 2 visit demonstrated more ADHD symptoms and more emotion dysregulation at Time 1. It is unclear how including these children's Time 2 data in the analyses would have changed the results. Fourth, this sample size was powered to detect medium and large effects, but not small effects, so any small effects may have been missed. Fifth, the number of analyses may have led to increased Type 1 error. Due to the small sample size, and in the interest of limiting Type 2 error, we did not correct for Type 1 error, so it will be important to replicate these findings. Lastly, the child self-report measure, Youth Emotion Scale, has not been validated. However, based on the factor structure, there appears to be some support for its validity.

Implications and Future Directions

These findings have important theoretical and clinical implications. These findings contribute to our theoretical understanding of the development of emotion dysregulation, suggesting that early neural and environmental factors both contribute to and interact in the development of emotion dysregulation. These findings are particularly relevant for children with ADHD symptoms, who are at risk for developing emotion dysregulation. These results suggest that high quality emotion socialization may have a protective effect, particularly for children whose neural markers put them at risk for emotion dysregulation, and that early exposure high quality emotion socialization may play an important role in preventing or reducing the severity of later emotion dysregulation. In children with ADHD symptoms, who are at-risk for altered neural markers, high quality emotion socialization may be an important intervention target for reducing emotion dysregulation. Future research should examine these findings across diverse racial/ethnic groups, and explore the mechanisms by which early environmental and neural factors contribute to the development of emotion dysregulation

APPENDIX A

CHILD SELF-REPORT OF EMOTION DYSREGULATION

Youth Emotion Scale

Read the following instructions to the child: “There are a lot of things that kids get upset about, but every kid is different. We want to know what it’s like when you get upset. I’m going to read you some sentences about getting upset and I want you to tell me for each one if it’s not really true for you, a little true for you, or a very true for you. Let’s do an example. So if I say, ‘I really like ice cream,’ would you say that’s not true for you, a little true, true, or very true? How about if I say, ‘I like cleaning my room.’ Would you say that’s not true for you, a little true, true, or very true?” Make sure the child understands the practice items before continuing.
Read each of the following statements to the child and then ask the child if it is “not true,” “a little true,” “true,” or “very true.”

	Not true	A little true	True	Very True
1. I get mad easily				
2. I get sad easily				
3. I get frustrated easily				
4. I get scared easily				
5. I get excited easily				
6. I have a hard time calming down when I get upset				
7. When I get upset I stay upset for a long time				
8. I have a hard time calming down when I get excited				
9. When I get upset I get over it quickly				
10. I stay upset even when people try to help me calm down				
11. When I get upset I go somewhere else to calm down				
12. When something upsetting happens I try to think happy thoughts				
13. When something upsetting happens I try to ask an adult for help				
14. When something upsetting happens I take deep breath to try to calm down				
15. When I get upset I try to do something to cheer myself up				
16. When I get upset I try to talk to someone about how I'm feeling				
17. When something upsetting happens, I try to				

change the thing that’s upsetting me.				
18. When something upsetting happens I try to think about something else				
19. When I get upset I tell myself it is not a big deal				
20. When I’m upset, I try to hide how I’m feeling.				
21. When I get excited, I take a deep breath to try to calm down				
22. When I get upset I yell and scream a lot				
23. When I get upset I throw a fit				
24. When I get upset I throw things				
25. When I get upset I hit people				
26. I lose my temper a lot				
27. I cry a lot				
28. When I get excited, I get really loud				

APPENDIX B

MATERNAL REPORT OF CHLD EMOTION DYSREGULATION

Emotion Regulation Checklist-Adapted Version

For each item below, please circle the number that best describes your child.

	Rarely/Never	Sometimes	Often	Almost Always
1. Is a cheerful child.	1	2	3	4
2. Has wild mood swings (changes unexpectedly from a good to a bad mood).	1	2	3	4
3. Responds positively when adults approach him/her in a friendly or neutral way.	1	2	3	4
4. Moves easily from one activity to another; doesn't become angry, anxious, upset, or overly excited when changing activities.	1	2	3	4
5. Gets over it quickly when he/she is upset or unhappy (doesn't pout, remain sullen, anxious or sad after upsetting events).	1	2	3	4
6. Is easily frustrated.	1	2	3	4
7. Responds positively when another child approaches him/her in a friendly or neutral way.	1	2	3	4
8. Is likely to have an angry outburst or easily throws tantrums.	1	2	3	4
9. Is able to wait for what he/she wants.	1	2	3	4
10. Seeing others unhappy gives	1	2	3	4

him/her pleasure (e.g., laughs when someone gets hurt or punished, enjoys teasing others).				
11. Can keep his/her excitement under control (e.g., doesn't get "carried away" in high-energy play situations or overly excited when it is not appropriate).	1	2	3	4
12. Is whiny of clingy with adults.	1	2	3	4
13. Is likely to have outbursts of energy and exuberance (or excitement) that are disruptive.	1	2	3	4
14. Responds angrily when an adult sets limits.	1	2	3	4
15. Is able to say when he/she is feeling sad, angry or made, fearful or afraid.	1	2	3	4
16. Seems sad or without energy.	1	2	3	4
17. When your child tries to play with others, he/she is overly exuberant (overly-excited).	1	2	3	4
18. Seems unemotional (e.g., child's expression is vacant or inexpressive; child seems emotionally absent).	1	2	3	4
19. When another child attempts in a friendly or neutral way to get your child to play or join in, he/she responds negatively (e.g., may speak in angry tone of voice or respond fearfully).	1	2	3	4
20. Is impulsive; does things without thinking.	1	2	3	4

21. Shares in feelings of others; shows concern when others are upset or unhappy	1	2	3	4
22. Displays excitement or enthusiasm that upsets or intrudes on others.	1	2	3	4
23. When another child acts aggressively toward child, he/she reacts appropriately (e.g., expresses anger, fear, frustration distress but does not return aggression).	1	2	3	4
24. When your child tries to get others to play, he/she shows negative emotion (anger, fear, frustration, distress).	1	2	3	4

APPENDIX C

MEASURE OF PARENTAL EMOTION SOCIALIZATION

Coping with Children's Negative Emotions Scale

Instructions: In the following items, please indicate on a scale from 1 (very unlikely) to 7 (very likely) the likelihood that you would respond in the ways listed for each item. Please read each item carefully and respond as honestly and sincerely as you can. For each response, please circle a number from 1-7.

Response Scale: 1 2 3 4 5 6 7
Very Unlikely Medium Very Likely

---

1. If my child becomes angry because he/she is sick or hurt and can't go to his/her friend's birthday party, I would:

a. send my child to his/her room to cool off 1 2 3 4 5 6 7
b. get angry at my child 1 2 3 4 5 6 7
c. help my child think about ways that he/she can still be with friends (e.g., invite some friends over after the party) 1 2 3 4 5 6 7
d. tell my child not to make a big deal out of missing the party 1 2 3 4 5 6 7
e. encourage my child to express his/her feelings of anger and frustration 1 2 3 4 5 6 7
f. soothe my child and do something fun with him/her to make him/her feel better about missing the party 1 2 3 4 5 6 7

2. If my child falls off his/her bike and breaks it, and then gets upset and cries, I would:

a. remain calm and not let myself get anxious 1 2 3 4 5 6 7
b. comfort my child and try to get him/her to forget about the accident 1 2 3 4 5 6 7
c. tell my child that he/she is over-reacting 1 2 3 4 5 6 7
d. help my child figure out how to get the bike fixed 1 2 3 4 5 6 7
e. tell my child it's OK to cry 1 2 3 4 5 6 7
f. tell my child to stop crying or he/she won't be allowed to ride his/her bike anytime soon 1 2 3 4 5 6 7

3. If my child loses some prized possession and reacts with tears, I would:

a. get upset with him/her for being so careless and then crying about it 1 2 3 4 5 6 7
b. tell my child that he/she is over-reacting 1 2 3 4 5 6 7

c. help my child think of places he/she hasn't looked yet 1 2 3 4 5 6 7
d. distract my child by talking about happy things 1 2 3 4 5 6 7
e. tell him/her it's OK to cry when you feel unhappy 1 2 3 4 5 6 7
f. tell him/her that's what happens when you're not careful 1 2 3 4 5 6 7

4. If my child is afraid of injections and becomes quite shaky and teary while waiting for his/her turn to get a shot, I would:

a. tell him/her to shape up or he/she won't be allowed to do something he/she likes to do (e.g., watch TV) 1 2 3 4 5 6 7
b. encourage my child to talk about his/her fears 1 2 3 4 5 6 7
c. tell my child not to make big deal of the shot 1 2 3 4 5 6 7
d. tell him/her not to embarrass us by crying 1 2 3 4 5 6 7
e. comfort him/her before and after the shot 1 2 3 4 5 6 7
f. talk to my child about ways to make it hurt less (such as relaxing so it won't hurt or taking deep breaths). 1 2 3 4 5 6 7

5. If my child is going to spend the afternoon at a friend's house and becomes nervous and upset because I can't be there with him/her, I would:

a. distract my child by talking about all the fun he/she will have with his/her friend 1 2 3 4 5 6 7
b. help my child think of things that he/she could do so that being at the friend's house without me wasn't scary (e.g. take a favorite book or toy with him/her) 1 2 3 4 5 6 7
c. tell my child to quit over-reacting and being a baby 1 2 3 4 5 6 7
d. tell the child that if he/she doesn't stop that he/she won't be allowed to go out anymore 1 2 3 4 5 6 7
e. feel upset and uncomfortable because of my child's reactions 1 2 3 4 5 6 7
f. encourage my child to talk about his/her nervous feelings 1 2 3 4 5 6 7

6. If my child is participating in some group activity with his/her friends and proceeds to make a mistake and then looks embarrassed and on the verge of tears, I would:

a. comfort my child and try to make him/her feel better 1 2 3 4 5 6 7
b. tell my child that he/she is over-reacting 1 2 3 4 5 6 7
c. feel uncomfortable and embarrassed myself 1 2 3 4 5 6 7
d. tell my child to straighten up or we'll go home right away 1 2 3 4 5 6 7
e. encourage my child to talk about his/her feelings of embarrassment 1 2 3 4 5 6 7
f. tell my child that I'll help him/her practice so that he/she can do better next time 1 2 3 4 5 6 7

7. If my child is about to appear in a recital or sports activity and becomes visibly nervous about people watching him/her, I would:

a. Help my child think of things that he/she could do to get ready for his/her turn (e.g., to do some warm-up and not to look at the audience) 1 2 3 4 5 6 7

b. suggest that my child think about something relaxing so that his/her nervousness will go away 1 2 3 4 5 6 7

c. remain calm and not get nervous myself 1 2 3 4 5 6 7

d. tell my child that he/she is being a baby about it 1 2 3 4 5 6 7

e. tell my child that if he/she doesn't calm down, we'll have to leave and go home right away 1 2 3 4 5 6 7

f. encourage my child to talk about his/her nervous feelings 1 2 3 4 5 6 7

8. If my child receives an undesirable birthday gift from a friend and looks obviously disappointed, even annoyed, after opening it in the presence of the friend, I would:

a. encourage my child to express his/her disappointed feelings 1 2 3 4 5 6 7

b. tell my child that the present can be exchanged for something the child wants 1 2 3 4 5 6 7

c. <u>NOT</u> be annoyed with my child for being rude 1 2 3 4 5 6 7

d. tell my child that he/she is over-reacting 1 2 3 4 5 6 7

e. scold my child for being insensitive to the friend's feelings 1 2 3 4 5 6 7

f. try to get my child to feel better by doing something fun 1 2 3 4 5 6 7

9. If my child is panicky and can't go to sleep after watching a scary TV show, I would:

a. encourage my child to talk about what scared him/her 1 2 3 4 5 6 7

b. get upset with him/her for being silly 1 2 3 4 5 6 7

c. tell my child that he/she is over-reacting 1 2 3 4 5 6 7

d. help my child think of something to do so that he/she can get to sleep (e.g., take a toy to bed, leave the lights on) 1 2 3 4 5 6 7

e. tell him/her to go to bed or he/she won't be allowed to watch any more TV 1 2 3 4 5 6 7

f. do something fun with my child to help him/her forget about what scared him/her 1 2 3 4 5 6 7

10. If my child is at a park and appears on the verge of tears because the other children are mean to him/her and won't let him/her play with them, I would:

a. <u>NOT</u> get upset myself 1 2 3 4 5 6 7

b. tell my child that if he/she starts crying then we'll have to go home right away 1 2 3 4 5 6 7

c. tell my child it's OK to cry when he/she feels bad 1 2 3 4 5 6 7

d. comfort my child and try to get him/her to think about something happy 1 2 3 4 5 6 7

e. help my child think of something else to do 1 2 3 4 5 6 7

f. tell my child that he/she will feel better soon 1 2 3 4 5 6 7

11. If my child is playing with other children and one of them calls him/her names, and my child then begins to tremble and become tearful, I would:

a.	tell my child not to make a big deal out of it	1 2 3 4 5 6 7
b.	feel upset myself	1 2 3 4 5 6 7
c.	tell my child to behave or we'll have to go home right away	1 2 3 4 5 6 7
d.	help my child think of constructive things to do when other children tease him/her (e.g., find other things to do)	1 2 3 4 5 6 7
e.	comfort him/her and play a game to take his/her mind off the upsetting event	1 2 3 4 5 6 7
f.	encourage him/her to talk about how it hurts to be teased	1 2 3 4 5 6 7

12. If my child is shy and scared around strangers and consistently becomes teary and wants to stay in his/her bedroom whenever family friends come to visit, I would:

a.	help my child think of things to do that would make meeting my friends less scary (e.g., to take a favorite toy with him/her when meeting my friends)	1 2 3 4 5 6 7
b.	tell my child that it is OK to feel nervous	1 2 3 4 5 6 7
c.	try to make my child happy by talking about the fun things we can do with our friends	1 2 3 4 5 6 7
d.	feel upset and uncomfortable because of my child's reactions	1 2 3 4 5 6 7
e.	tell my child that he/she must stay in the living room and visit with our friends	1 2 3 4 5 6 7
f.	tell my child that he/she is being a baby	1 2 3 4 5 6 7

APPENDIX D

THE TABLES

Table 1. YES Factor Loadings based on Principal Components Analysis with Direct Oblimin Rotation.

YES Item	Adaptive ER	Reactivity	Maladaptive ER
I get mad easily	-.040	**.624**	.264
I get sad easily	-.064	**.712**	.040
I get frustrated easily	.144	**.716**	-.072
I get scared easily	.134	**.648**	-.141
I get excited easily	**.488**	.172	.104
I have a hard time calming down when I get upset	.007	.377	**.405**
When I get upset I stay upset for a long time	-.211	**.605**	.088
I have a hard time calming down when I get excited	.233	.391	**.400**
When I get upset I go somewhere else to calm down	**.464**	.244	-.072
When something upsetting happens I try to think happy thoughts	**.828**	.140	-.154
When something upsetting happens I try to ask an adult for help	**.626**	-.206	-.362
When something upsetting happens I take deep breath to try to calm down	**.647**	-.181	.227
When I get upset I try to do something to cheer myself up	**.654**	.130	-.183
When I get upset I try to talk to someone about how I'm feeling	**.635**	-.272	-.032
When something upsetting happens, I try to change the thing that's upsetting me.	**.654**	-.148	-.006
When something upsetting happens I try to think about something else	**.732**	-.197	-.150
When I get upset I tell myself it is not a big deal	**.704**	.053	-.001
When I'm upset, I try to hide how I'm feeling.	.264	.316	**.441**
When I get excited, I take a deep breath to try to calm down	**.578**	.010	.292
When I get upset I yell and scream a lot	-.187	.185	**.590**
When I get upset I throw a fit	-.268	-.131	**.463**
When I get upset I throw things	**-.481**	.121	**.484**
When I get upset I hit people	-.223	-.167	**.653**

I lose my temper a lot	.007	**.413**	.250
I cry a lot	.323	.244	.373
When I get excited, I get really loud	.250	.073	**.577**

Note. Factor loadings >.4 are in boldface. YES = Youth Emotion Scale.

Table 2. Intercorrelations and Descriptive Statistics for Time 1 and Time 2 Variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Support ES	--																					
2. Nonsup ES	-.35**																					
3. Distress ES	-.09	.35**																				
4. ES Quality	.84**	-.76**	-.44**																			
5. P1 bsl	-.07	.03	-.16	-.02																		
6. P1 fru	.06	-.11	-.06	.11	.20																	
7. P1 reg	.00	-.07	.-6	.02	-.06	.12																
8. P1 rec	.17	-.02	-.17	.17	.00	.11	-.04															
9. N2 bsl	.11	.03	-.07	.07	.82**	.12	-.16	.00														
10. N2 fru	.23†	.01	-.12	.17	.20	.71**	.00	.02	.24†													
11. N2 reg	.14	-.14	-.06	.17	-.22†	.17	.73**	.05	-.17	.08												
12. N2 rec	.22†	.02	-.13	.17	.08	.13	.00	.80**	.18	.15	.14											
13. P3 bsl	.19	-.01	.04	.12	.52**	.11	-.12	-.15	.80**	.28*	-.07	.10										
14. P3 fru	.17	.00	-.08	.13	-.02	.38**	-.02	-.16	.05	.72**	.12	.00	.30*									
15. P3 reg	-.08	-.10	.03	-.01	-.12	-.01	.53**	-.21	-.10	.02	.67**	.-2	.14	.27*								
16. P3 rec	.23†	-.10	.00	.11	-.04	.00	-.01	.55**	.05	.06	.15	.78**	.13	.12	.13							
17. YES Adap	-.23	.04	-.06	-.17	.004	.12	-.15	-.05	.06	.17	-.21	-.04	.12	.21	-.03	-.14						
18.YES React	.14	-.08	.13	.10	-.06	-.25†	.11	-.11	-.09	-.17	.14	-.16	-.15	-.15	.16	-.10	-.03					
19.YES Mal	-.14	.03	.16	-.16	-.08	-.11	-.04	-.07	.06	-.22	.06	.05	.23	-.17	.20	.15	.01	.26†				
20. T2 ERC	-.06	.31*	-.05	-.17	-.05	-.34*	.09	-.28	-.10	-.36*	.10	.16	-.16	-.20	.23	-.12	-.08	.07	.19			
21. Obs fru	-.30*	.15	-.32*	-.20	.13	.20	.06	.39**	-.01	.13	.08	.20	-.14	-.01	.01	-.01	.28†	-.12	.09	.16		
22. T1ERC	-.17	.10	.03	-.16	.06	-.16	-.13	-.17	.05	-.26*	-.07	-.11	.02	-.05	.06	-.13	.14	-.01	.17	.67**	.28	
N	67	67	67	67	59	59	59	59	59	60	60	60	59	60	60	59	49	49	49	49	49	68
M	5.66	2.24	3.42	5.51	1.04	1.30	.78	1.3	.66	1.60	1.20	1.54	1.32	3.26	2.69	3.28	2.41	1.79	1.88	1.62	.10	1.74
SD	.68	.68	.71	.50	2.59	1.71	2.23	2.98	3.19	2.40	2.61	3.74	4.08	3.58	3.15	4.51	.67	.61	.46	.43	.22	.41
Skewness	-.76	1.01	.002	-.61	-.61	-.13	.049	-.26	-.21	.23	-.44	.13	-.28	1.12	-.49	-.07	-.06	.89	.67	.86	1.3	.20

Note. ES = emotion socialization; Bsl = baseline; Fru = frustration Rec = Recovery; Reg = Regulation; P1 and N2 = collapsed ERP amplitudes at F3, F4, & FZ; P3 = collapsed ERP amplitudes at FC3, FC4, & FCZ; YES = Youth Emotion Scale; Adapt = Adaptive ERsubscale; React = Reactivity subscale; Mal =Maladaptive ER subscale; T1 = Time 1; T2 = Time 2; Obs = observed; ERC = Emotion Regulation Checklist

***$p < .001$, **$p < .01$, *$p < .05$, †$p \leq .10$.

Table 3. Summary of Regression Analysis for Emotion Socialization and Neural Markers Predicting Emotion Dysregulation

	YES Adaptive ER			YES Reactivity			YES Maladaptive ER			ERC			Observed Frustration		
Variable	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*
Emotion Socialization															
Supportive	-.20(.16)	-.20	.213	.11(.15)	.13	.442	-.06(.10)	-.08	.584	-.01(.08)	-.01	.912	**-.06(.03)**	**-.34**	**.015**
Unsupportive	-.05(.19)	-.05	.809	-.09(.17)	-.10	.608	-.01(.13)	-.02	.931	**.27(.12)**	**.39**	**.021**	.03(.03)	.17	.348
Distress	-.08(.14)	-.08	.560	.14(.13)	.16	.285	.09(.09)	.14	.315[1]	00(.07)	-.00	.974	**-.05(.02)**	**-.32**	**.015**
P1 (F3,F4,FZ)															
Baseline	-.01(.04)	-.05	.709	.00(.04)	.01	.972	-.01(.03)	-.07	.626	-.01(.02)	-.08	.419	.00(.01)	.07	.555
Frustration	.07(.06)	.17	.239[1]	-.10(.06)	-.28	.085	-.02(.04)	-.06	.696	-.04(.03)	-.16	.155	.01(.01)	.18	.165
Regulation	-.02(.04)	-.08	.556	.02(.04)	.08	.603	.01(.03)	.03	.835	.04(.02)	.18	.068	.01(.01)	.13	.249
Recovery	-.01(.03)	-.03	.832	-.02(.03)	-.08	.637	-.00(.02)	-.01	.920	-.02(.02)	-.12	.276	**.02(.01)**	**.43**	**<0.001**
N2 (F3,F4,FZ)															
Baseline	-.02(.03)	-.09	.494	.01(.03)	.03	.873	.02(.02)	.11	.445	-.01(.02)	-.05	.628	.00(.01)	-.11	.408
Frustration	**.09(.05)**	**.30**	**.051**	-.05(.05)	-.20	.284	-.04(.03)	-.22	.171	-.04(.02)	-.20	.116	.01(.01)	.22	.147
Regulation	-.04(.04)	-.15	.281	.03(.04)	.15	.337	.02(.02)	.11	.398	**.04(.02)**	**.20**	**.045**	.00(.01)	.08	.541
Recovery	.00(.03)	.01	.930	-.03(.03)	-.19	.244	.01(.02)	.11	.447	-.01(.01)	-.06	.600	.01(.00)	.21	.123
P3(FC3,FC4,FCZ)															
Baseline	.00(.02)	.02	.852	-.01(.02)	-.09	.549	.03(.02)	.22	.083	-.02(.01)	-.14	.175	.00(.00)	-.16	.264
Frustration	**.07(.03)**	**.37**	**.013**	-.03(.04)	-.18	.375	**-.04(.02)**	**-.31**	**.052**	-.02(.02)	-.18	.182	.00(.01)	.07	.705
Regulation	.00(.03)	-.01	.968	.04(.03)	.19	.188	.03(.02)	.21	.078	**.04(.01)**	**.26**	**.007**	.00(.01)	.00	.976
Recovery	-.03(.02)	-.16	.234	-.02(.02)	-.14	.442	.02(.02)	.21	.123	-.01(.01)	-.07	.538[2]	.00(.00)	.03	.848

Note. All regressions controlled for Time 1 ERC and gender.

Table 4. Summary of Emotion Socialization and Neural Markers Interaction Regressions

	YES Adaptive ER			YES Emotion Reactivity			YES Maladaptive ER			ERC			Observed Frustration		
Interaction	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*
P1XES	**-.26(.15)**	**-.33**	**.050**	**.44(.12)**	**.58**	**<.001**	-.02(.10)	-.04	.828	.06(.08)	.12	.429	**-.04(.02)**	**-.31**	**.038**
N2XES	**-.25(.10)**	**-.37**	**.006**	.16(.11)	.26	.118	.01(.08)	.03	.859	.00(.06)	.00	.992	.00(.02)	.03	.869
P3XES	**-.17(.09)**	**-.34**	**.029**	.13(.08)	.31	.098	**.13(.06)**	**.40**	**.010**	.00(.05)	-.01	.951	.01(.02)	.11	.601

Note. All regressions controlled for gender, Time 1 ERC, and the respective ERP components during other Posner blocks.

Table 5. Summary of Simple Slopes for Significant Interactions.

	High Emotion Socialization			Moderate Emotion Socialization			Low Emotion Socialization		
Predictor → Outcome	*b (SE)*	β	*p*	*b (SE)*	β	*p*	*b (SE)*	β	*p*
P1→ YES Adaptive ER	-.03(.08)	-.07	.723	.10(.06)	-.13	.315	**.22(.10)**	**.53**	**.017**
P1→ YES Reactivity	.07(.07)	.17	.306	**-.14(.05)**	**-.35**	**.002**	**-.34(.08)**	**-.87**	**<.001**
P1→ Obs Frustration	.00(.01)	-.05	.740	**.02(.01)**	**.23**	**.053**	**.04(.02)**	**.51**	**.011**
N2→ YES Adaptive ER	.00(.05)	.03	.882	**.13(.05)**	**.43**	**.002**	**.25(.08)**	**.83**	**<.001**
P3→ YES Adaptive ER	.03(.04)	.15	.403	**.11(.04)**	**.52**	**<.001**	**.19(.07)**	**.90**	**<.001**
P3 → YES Maladaptive ER	-.01(.02)	-.06	.721	**-.07(.02)**	**-.51**	**.001**	**-.13(.06)**	**-.95**	**<.001**

Note. P1 and N2 = collapsed ERP amplitudes at F3, F4, & FZ during reactivity block; P3 = collapsed ERP amplitudes at FC3, FC4, & FCZ during reactivity block; YES = Youth Emotion Scale; Obs = observed; ERC = Emotion Regulation Checklist

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